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Autorregúlate, a Methodology to support self-regulated learning in MOOC courses

Autorregúlate, Una metodología para apoyar el aprendizaje autorregulado en cursos MOOC

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Abstract

Global education is facing major challenges, including the lack of strategies and methods to ensure that students are truly engaged in the learning process, self-regulating their learning, and promoting successful completion of the educational process. In this research, we introduce Autorregúlate, a methodology to support self-regulated learning in Massive Open Online Courses (MOOCs), which from the design of the MOOC contributes to maintaining motivation and self-regulation throughout the course. Autorregúlate provides concrete and easy-to-implement guidelines for diverse teams in the creation of MOOCs, based on Zimmerman's self-regulation model. The methodology was validated in real MOOC courses using two evaluation instruments, the Questionnaire OSLQ and the Keller's Motivation Survey. Results show high levels of motivations (M=3,83; SD=0,7). On the other hand, results revel self-regulation strategies adoption by the participants, in particular, Goal setting (M=4,0; SD=0,7), Environmental structuring (M=4,1; SD=0,7), Task strategies (M=3,7; SD=0,7), Time management (M=3,84; SD=0,8), Seeking help (M=4,1; SD=0,8) and Self-evaluation (M=4,0; SD=0,7). Therefore, Autorregúlate support students on self-regulating their learning while achieving a sustained motivation.

Keywords: ADDIE; Self-regulation; MOOC; Educational technology; UDL.

Resumen

La educación a nivel global está enfrentando grandes desafíos, incluyendo la falta de estrategias y métodos para asegurar que los estudiantes estén verdaderamente comprometidos en el proceso de aprendizaje, autorregulando su aprendizaje y promoviendo la finalización exitosa del proceso educativo. En esta investigación, se presenta Autorregúlate, una metodología para apoyar el aprendizaje autorregulado en cursos online masivos y abiertos (MOOCs), que desde su diseño contribuyen a mantener la motivación y la autorregulación a lo largo del curso. Autorregúlate proporciona pautas concretas y fáciles de implementar para equipos diversos en la creación de MOOCs, basadas en el modelo de autorregulación de Zimmerman. La metodología fue validada en cursos MOOC reales, utilizando dos instrumentos de evaluación: el Cuestionario OSLQ y la

Encuesta de Motivación de Keller. Los resultados mostraron niveles altos de motivación (M=3,83; SD=0,7). Por otro lado, los resultados revelaron la adopción de estrategias de autorregulación por parte de los participantes, en particular: Establecimiento de objetivos (M=4,0; SD=0,7), Estructuración del entorno (M=4,1; SD=0,7), Estrategias de tareas (M=3,7; SD=0,7), Gestión del tiempo (M=3,84; SD=0,8), Búsqueda de ayuda (M=4,1; SD=0,8) y Autoevaluación (M=4,0; SD=0,7). Por tanto, Autorregúlate apoya a los estudiantes en la autorregulación de su aprendizaje mientras logran una motivación sostenida.

Palabras clave: ADDIE; Autorregulación; MOOC; Tecnología educativa; UDL.

Introduction

Massive Open Online Courses (MOOCs) are participatory, distributed courses, with a publicly shared curriculum, that support lifelong learning in networks (McAuley et al., 2010). Within the difficulties that arise in the context of the realization of these courses, the high dropout rate of the participants can be highlighted, due to different causes such as the poor quality of the courses, the deficient time management by the participants, the lack of basic knowledge and skills, unsatisfactory learning experiences in the courses, the lack of interaction with the instructor, the lack of motivation, the little attention to the diverse needs of the participants, or the lack of strategies on the part of the participants of these courses to self-regulate their learning process (Gütl et al., 2014).

As a result of the aforementioned, several lines of research have been created in the field of MOOCs as objects of study, among which the following stand out: specification of the processes of creating MOOCs (Alario-Hoyos et al., 2015; Meléndez et al., 2016; Montoya et al., 2019), gamification as a didactic strategy in MOOCs (Khalil et al., 2018), quality evaluation of MOOCs (Zhu et al., 2018), analysis of interaction of participant in MOOCs (Maldonado-Mahauad et al., 2018), accessibility in MOOC content (Sanchez-Gordon & Luján-Mora, 2018), as well as support for self-regulated learning (SRL) (Lee et al., 2018; Pérez-Álvarez et al., 2018; Sambe et al., 2018).

The main focus of this article is centered on the self-regulated learning as a process that must be supported in the context of MOOCs, for participants to complete their learning processes in these massive online courses (Maldonado et al., 2016; Pérez-Álvarez et al., 2017).

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The self-regulation of learning is defined by Zimmerman (2000) as "to self-generated thoughts, feelings, and actions that are planned and cyclically adapted to the attainment of personal goals" (p. 14). When a student cannot self-regulate their learning, they will likely abandon the activity they are working on due to different factors or situations they may face, such as not having a suitable work environment, not adequately planning educational purposes, as well as poor time management, lack of monitoring, and self-evaluation of the activities carried out.

The importance of self-regulation in the learning process of a human being is such that throughout history, several models have been created from psychology and psycho-pedagogy that explains, from different perspectives, how the process of self-regulated learning is conceived. Among these models, those proposed by Zimmerman y Moylan (2009), Boekaerts (1999), Winne y Hadwin (1998), Pintrich (Schunk, 2010), Efklides and Hadwin (Efklides, 2006), Järvelä et al. (2018) stand out, which have been well characterized by Panadero (2017).

However, according to the systematic literature review published by Ceron et al. in 2020, no MOOC course methodologies are reported to support self-regulated learning from the design. Therefore, this article introduces the methodology called Autorregúlate, as a strategy that supports the process of creating MOOCs from their design, favoring self-regulated learning in these courses.

The methodology is based on three conceptual principles, Zimmerman's self-regulated learning model (Zimmerman, 2000), Universal Design for Learning (UDL) (Meyer et al., 2014) as a conceptual framework that helps reduce barriers in virtual courses due to inflexible design, and the ADDIE model (Carrillo & Carlos, 2019) that guarantees a clear systematic process in the execution of the methodology.

This article is structured as follows: Section II presents the analysis of the works related to this study, Section III details the Autorregúlate methodology, Section IV describes the evaluation carried out to validate the methodology, Section V describes the discussions around the study, and finally, Section VI outlines conclusions and future work.

Related works

As noted in their study (Alonso-Mencía, Alario-Hoyos & Delgado-Kloos, 2019; Alonso-Mencía, Alario-Hoyos, Maldonado-Mahauad et al., 2019), studies on supporting self-regulated

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learning (SRL) in MOOC contexts agree that research on SRL in MOOCs is still scarce and tends not to specify which SRL model is used. Below, we describe some of the efforts made to date which describe the advances in this field.

In the first place, different tools to support self-regulated learning in MOOC contexts have been developed. In their study, Alonso-Mencía, Alario-Hoyos y Delgado-Kloos (2019) presented MOOCnager, a Chrome extension to help students improve their SRL skills. Specifically, this work focuses on supporting 3 self-regulation strategies: goal setting, time management, and self-evaluation. Each strategy is framed in one of the 3 phases that compose Zimmerman's SRL cycle. The results were inconclusive, as the use of the extension by participants was very low. However, it was concluded that students seem to prefer a tool integrated into the MOOC platform.

Continuing with the line of research on tools to support SRL, according to the studies by Pérez-Álvarez et al. (2017), who in their research analyzed existing software tools to support self-regulation in MOOCs, it is concluded that there are very few tools and they do not provide enough SRL support features for students to self-regulate. Based on their findings, the authors developed an application called NoteMyProgress, which was evaluated by 4 experts from different countries and 18 students. The results obtained indicate that the experts evaluated the application positively as a tool to support SRL, while the students consider the included features useful for managing their time and organizing their learning process. However, the tool was tested by very few users due to the short duration of the study, which was two weeks. On the other hand, another limitation of the study was that only one evaluation test of concepts was applied as the only instrument, which does not comprehensively measure the self-regulation process achieved by students concerning their learning.

Other tool reported in literature is eLDa, a platform developed by Onah y Sinclair (2017), for delivering computer concepts. Using this platform, Onah y Sinclair conducted a study that revealed the effectiveness of virtual and traditional teaching for an undergraduate MOOC of Python. 107 individuals participated in this research, and an online Self-Regulated Learning Questionnaire (OSLQ) was used as a tool to measure students' self-regulated learning skills. The study concludes that self-regulated learning is an important factor in the success of MOOC-based studies and that the eLDa tool is a promising in supporting self-regulated learning according to the preliminary evaluation carried out in this research.

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On the other hand, data that come from the use of the developed tools or from participants interaction in MOOCs have been analyzed with interesting results. Cerezo et al. (2019), in their studies, using process mining techniques, investigated how students self-regulated their learning, identifying SRL skills of the students during the development of the MOOC. The study concluded that, although the students who passed did not exactly follow the instructors' suggestions, they did follow the logic of a successful self-regulated learning process.

Continuing in the line of data analysis, Won et al. (2019) conducted a study on how students in MOOCs use SRL supports, exploring sequences of activities of the students. In the MOOC used in the study, videos were made available to the participants that explain and invite self-regulation. The results report that students who followed the SRL guidelines better followed the course structure than those who did not, and students who saw more SRL messages interacted with more elements of the course.

In the same field of data analysis, Maldonado-Mahauad et al. (2018) investigated how to predict the success of learners in a MOOC through the identification of patterns of self-regulated learning sequences. They identified two groups of students: first, those who follow the course path designed by the teacher, and second, those who seek the information required to pass assessments.

Finally, in this line of data analysis, Kizilcec et al. (2017) indicate that it is not only a matter of training students to use a support system for self-regulated learning or actively supporting them with suggestions and activities but effective implementation of support systems in MOOCs requires understanding which SRL strategies are most effective and how these strategies manifest in the online behavior of participants. This study takes this fundamental idea to inform the design of the Autorregúlate methodology.

Although progress has been made to support self-regulated learning in MOOCs, there are still open questions that must be addressed. For instance, to the best of our knowledge, there are no methodological frameworks that inform or guide the design and development of MOOCs to promote self-regulated learning.

In this context, the Autorregúlate methodology has been designed, based on educational problems identified in real environments, to guide designers in creating scenarios that support self-regulated learning. In this sense, the research question that guides the study presented in this

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document is: Is it possible to support MOOC designers to achieve better support for self-regulated learning from the design of the MOOC?

Autorregulate methodology

The lack of guideline to support MOOC designers to consider self-regulation strategies from the MOOC design motivate us to create the Autorregúlate methodology with the main objective to provide clear and easy to implement guidelines based on the conceptual frameworks of the during the MOOC creation that support self-regulated learning.

The process followed to create Autorregúlate methodology was: i) The definition of Guiding principles define the theoretical bases that support the methodology implementation; ii) the definition of Actors define the participants' roles in charge to carry out the methodology; iii) the description of Use Cases describe contexts where the methodology could be implemented; and; iv) the definition of the Stages which describe what are the steps to be followed in the methodology implementation.

Figure 1 shows the general outline of the Autorregúlate methodology. Next paragraphs describe each element in detail.

Guiding principles

The Autorregúlate Methodology is based on three guiding principles: 1) Autorregúlate supports self-regulated learning, based on Zimmerman's self-regulated learning model (Zimmerman, 2008) by offering students a process in which they can plan their learning activities, carry them out, and self-reflect on their actions; 2) Autorregúlate addresses diversity by adopting the Universal Design for Learning (Rose et al., 2014) which through its three principles in the curriculum design process: a) Providing multiple means of representation, b) Providing multiple means of action and expression, and c) Providing multiple means of engagement, facilitates attention to student variability in a MOOC; 3) Autorregúlate offers a systematic process to MOOC designers, through the adoption of the A.D.D.I.E. model (Kurt, 2018) which allows designers to have a structured and

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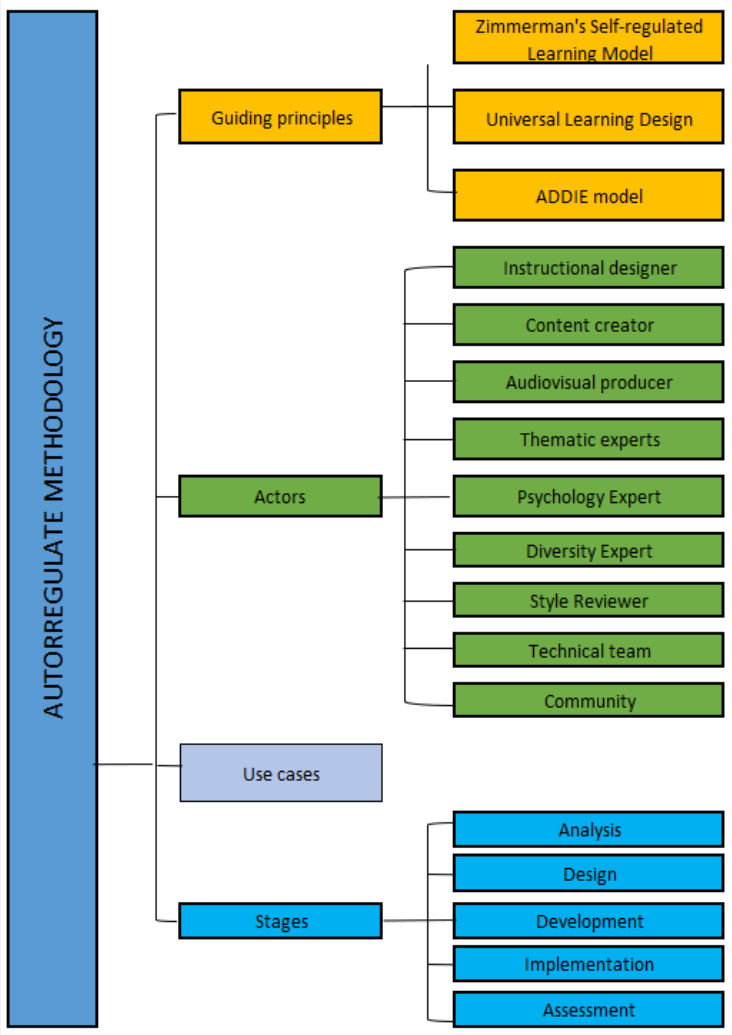
systematic approach to the design and development of massive online courses, through its Analysis, Design, Development, Implementation, and Evaluation stages.

Figure 1

General Structure Autorregúlate Methodology



Actors

The Autorregúlate methodology is based on co-creation, understanding that it "requires new tools, methods, and a new design language. The designer must accept the participation of new partners in the design process and adopt a new attitude about the inherent creativity of ordinary"

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(Sanders, 2006). Therefore, in Autorregúlate, co-creation allows designing and developing MOOC courses with the support of multidisciplinary teams of people, considering their contributions from the professional field and their experience. In this sense, the community goes from being a simple consumer to being a producer, considering in the process of creating MOOC their interests, needs, and preferences, as they act as co-creators of the content.

In this context, Autorregúlate proposes a series of actors who actively participate in the co-creation process: a) Instructional Designer who guides the co-creation work of the design and development team. b) Content Creator whose main objectives are to create, update and monitor the consistency and effectiveness of the produced contents, to verify that they are functional and impactful. c) Audiovisual Producer who participates in the recording and editing of videos. d) Experts in thematic areas who contribute their experience to enrich the contents of the MOOC. e) Psychology expert who supports the understanding and direction of the three phases of Zimmerman's model during the design stage, as well as the use and design of support technology for each stage of the model, planning, execution and self-reflection. f) Diversity expert who helps implement UDL principles by applying pedagogical and didactic strategies that allow all people to have the same opportunities to learn, regardless of their conditions, needs, or preferences. g) Style Reviewer in charge of reviewing the writing, correcting spelling, lexical, and syntax errors. h) Content Technician in charge of assembling the virtual platform on servers, either locally or in the cloud. In addition to uploading all the created content and placing it on the virtual platform, they are aware of all technical and computer events that may arise. i) Finally, The Community, which participates as the main actor in defining the training needs, as well as in eliciting problems that must be addressed in the educational process. The participation of this actor is a differentiating factor of the Autorregúlate Methodology. Research on the creation of MOOCs worldwide, in most cases, shows that these courses are created in large universities and with the best content production centers and experts in each subject (Montoya et al., 2019). However, it is in the community and with the community where real problems affecting many populations can be analyzed. In this way, it is possible to prioritize the training needs that emerge from the communities themselves by offering open offerings that can help address these needs.

It is important to emphasize that by involving the community in such a way that social demands are addressed in open education processes, the fourth objective of the UN's sustainable

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development is oriented: “Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all” (Gómez-Lee, 2019).

Use cases

Autorregulate can be used as 1) A guide for creating new MOOCs; 2) A guide for improving existing MOOCs, promoting self-regulated learning in courses; 3) A guide for applying Universal Design for Learning in MOOCs; 4) A strategy for reducing participant dropout rates in MOOCs; or 5) A guide for increasing student motivation levels in MOOCs.

Stages

The Autorregúlate methodology defines a series of stages, enriched with templates and annexes, that allow for the systematization of the methodological process. These stages are described in the following paragraphs.

Analysis

The main purpose of the analysis stage is to identify the needs and preferences of stakeholders, as well as to achieve a descriptive vision of the MOOC to be developed. In this stage, the participation of the community and the target group for the MOOC is important.

Regarding the construction of a descriptive vision of the MOOC, it is important to consolidate concrete elements as a team, such as the name of the MOOC, its description, the related areas of knowledge, a clear description of the MOOC, objectives, those responsible (facilitators, tutors, etc.), duration, modules organized in weeks, certification to be offered to participants, the institution offering it and language, among other aspects. In the following link, it is possible to find the Initial Descriptive Document Template for the MOOC (Document) co-created in this stage.

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Design

One of the main actions of this phase carried out by the MOOC co-creation team is the definition of a detailed plan of the activities to be carried out by the participants in the different weekly modules defined in the initial descriptive document template of the MOOC, specifying their objectives, execution times, learning strategies, and appropriate means to be used in creating the MOOC. This planning must be very detailed since it will be the basis of development.

To promote student self-regulation strategies, MOOC course design must ensure that: MOOC objectives are clear and adaptable, thus supporting the SRL strategy of setting goals. The activities must be applicable in real life, that is, contextualized and located, strengthening the SRL strategy of interest and value for the task. The heterogeneity in the tasks must be capitalized, creating attractive content for diverse people and supporting the SRL strategy of expectation of results. Barriers must be broken in terms of everything that is done within MOOCs, encouraging the use of social networks to support the SRL strategy of seeking help (Littlejohn & Milligan, 2015).

MOOCs should be productive for the participants, achieving significance in the individual beyond the pursuit of a certificate, motivating the SRL strategy to encourage interest in the task.

Once the planning has been defined, it must be analyzed in light of Universal Design for Learning, ensuring compliance with its three basic principles: 1) provide multiple levels of engagement, 2) provide multiple means of representation, and 3) provide multiple means of action and expression (Rose et al., 2014). This analysis will identify possible barriers that may pose challenges to satisfactory learning by students, which should be removed, and on the other hand, identify previously unseen opportunities that can help the learning of all participants, which should be utilized.

To support the design of MOOCs, the following templates were created: a) Weekly Planning Template: This template schedules the modules to be completed by week with their respective topics. b) Template to support self-regulated learning strategies: This template provides recommendations on how to design and create MOOCs referencing self-regulated learning strategies. c) Universal Design for Learning Verification Template: This template analyzes the Universal Design for Learning guidelines in detail. In the following link. It is possible to find the set of Design Templates (Plta1, Plta2, Plta3)

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Development

In this stage, the MOOC co-creation team, using the data collected from the previous two stages, creates the MOOC that will allow participants to achieve the learning objectives set. In this stage, all actors participating in the methodology play a fundamental role in creating the MOOC, following the roles indicated in sub-section B of this section.

Different tools can be used in this stage for content creation and to promote the UDL principle of providing multiple means of representation, such that students can see the same content in different formats like audio, video, and text.

Among the recommended tools to use are programs like TextAloud that allow text to be converted to audio (preferably in mp3 format) making the content accessible in cases where the participant has a visual impairment or people who prefer to learn not by reading but by listening to the content.

On the other hand, it is recommended to edit recorded videos in Camtasia, exporting them to YouTube so that functions such as subtitles can be activated to cater to the preferences of people who have hearing impairments, also activating the options to switch languages so that the content offered is more universal.

The documents created are suggested to be worked on in Portable Document Format (PDF), which is one of the internet standards, easy to manage, and compatible with any browser.

Implementation

In the implementation phase, the technical team loads the content on the platform selected, in a structured manner according to the planned theme and order.

In this phase, it is recommended to carry out pilot tests with small groups to validate and analyze each of the resources and activities presented. This feedback is important so that when the course is officially launched, there is no need to make changes to the content during its execution.

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Evaluation

The evaluation of a MOOC designed following the Self-Regulated Methodology should consider at least the following types of evaluation:

Evaluation of participant motivation

Motivation is generally defined as what explains the direction and magnitude of behavior, or in other words, explains what goals people choose to pursue and how actively or intensely they pursue them (Keller, 2012).

To evaluate motivation, it is recommended to use the instrument of John M Keller's ARCS model (Keller, 2012) which evaluates four dimensions of learning motivation: Attention, Relevance, Confidence, and Satisfaction (Document).

The Attention dimension refers to the MOOC's ability to attract and maintain the attention of learners during the learning process, including perceptual activation and stimulation of inquiry. The Relevance dimension refers to the MOOC's ability to link learning to learners' prior knowledge, personal needs, and life experience, including familiarization, goal orientation, and motivation match. The Confidence dimension allows the evaluation of learners' freedom to learn in the MOOC and their ability to maintain the desire for success through various methods, including expected success, challenging situations, and attribution methods, among others. The Satisfaction dimension validates the extent to which learners in the MOOC feel the value of learning, enjoy learning, and can obtain satisfaction in learning, including natural outcomes, positive results, and equity, among others.

Self-regulated Learning Evaluation

To evaluate self-regulated learning, it is recommended to apply the OSLQ questionnaire (Online Self-Regulated Learning Questionnaire) created by Barnard et al. (2009). (See questionnaire).

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The online self-regulated learning questionnaire (OSLQ) has been designed to assess the self-regulation ability of students represented in six subscales that constitute self-regulation strategies. These subscales are goal setting (5 questions), environmental structuring (4 questions), task strategies (4 questions), time management (3 questions), seeking help (4 questions), and self-evaluation (4 questions). These strategies are evaluated throughout the 24 items that make up the questionnaire with responses on a Likert scale of 1 to 5 where 5 is completely agree and 1 completely disagree.

The OSLQ questionnaire was selected, as it is the most used to validate self-regulated learning in online environments with high reliability, as shown by Cerón et al. (2020) in their systematic literature review.

Evaluation of the Autorregulate methodology

Concept

This study was developed under a post-positivist research paradigm, with a quantitative research approach (Hernández-Sampieri et al., 2018). The research design had a descriptive scope, in which different dimensions and variables were measured and evaluated without establishing correlations between them (Ramos, 2015). It was a quasi-experimental design carried out after the creation and subsequent implementation of a MOOC course called Environmental Management and Sustainable Development, organized with 154 participants.

The evaluation of the "Environmental Management and Sustainable Development" MOOC sought to generate evidence on three fundamental aspects: 1) the effect of the MOOC design on students' self-regulated learning, 2) the effect of the MOOC design on students' motivation, and 3) the academic performance of MOOC participants.

Participants

In this scenario, 154 people from different parts of Colombia participated. 91 of the participants were women (59.1 %) while 63 (40.9 %) were men.

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Participants had different levels of education: Doctorate students 1 (0.6 %), Master's 12 (7.8 %), University degree 83 (53.9 %), Vocational-technical 10 (6.5 %), Secondary education 40 (26 %), Primary education 0, and Formal education 8 (5.2 %).

Regarding the age of the participants, 6.5 % (10) were young people under 15; 25.3 % (39) were young people between 15 and 25 years old; 60.4 % (93) were young people between 26 and 39 years old; 7.1 % (11) were people between 40 and 64 years old; 0.6 % were people 65 years old or older.

Evaluation scenario

The evaluation scenario for the Autorregúlate Methodology was a MOOC designed in the context of the International Social Justice Repair Kit project (SJRK) (OAK FUNDATION, 2018). The SJRK project goal was to co-design and iteratively build or refine multiple online resources that provide access to social justice, open data, youth activism, and resources for youth movements in project impact locations. The resources designed during the project ensured full inclusion of users with learning differences.

In this setting, the MOOC called “Environmental Management and Sustainable Development” was developed for young Colombians following the Stage of the Autorregúlate Methodology. This MOOC was designed with the purpose of promoting the learning of technical and theoretical concepts on the care and conservation of natural resources, as well as on the different types of environmental pollution and possible solutions to environmental impacts, mitigation measures for the recovery of the environmental component, emphasizing the proper use of renewable energies.

The distinguishing feature in the creation of MOOCs in the Social Justice Repair Kit project was the direct participation of the community. The people who were involved were young people from the city of Mocoa between 14 and 28 years old, who represent 26.29 % of the population. Mocoa has a population of 56,398 inhabitants according to the municipal population projection by area of the National Administrative Department of Statistics (Ministerio de Hacienda y Crédito Público, 2019), of which 14,663 are young people.

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During the design stage, the LMS Moodle tool was selected as the learning management system to be used in the creation of the MOOC on Environmental Management and Sustainable Development. Moodle is a web-based learning management system (LMS), provided free as open-source software as an alternative to manage teaching/learning processes. Moodle is one of the most popular online platforms used for educational purposes (De Medio et al., 2020). The use of Moodle as a learning management system was based on the findings of the systematic review of the literature that was carried out in this research, which indicated that it was one of the most used LMS in studies regarding MOOCs (Cerón et al., 2020).

For this scenario, seven self-regulated learning strategies were identified to be supported using the Moodle functionalities. Strategies were previously highlighted as the most important in the literature according to the systematic review of the literature by Cerón et al. (2020). These strategies were goal setting, help seeking, time management, strategic planning, self-monitoring, organization and self-assessment. Considering their characterization according to the model of Zimmerman y Moylan (2009), Table 1 shows how this strategies could be addressed using the Moodle functionalities.

Table 1

Moodle and Self-regulated learning

Strategies SRL	Actions on the MOODLE Platform
Goal setting	Goal are clearly defined in each module of the course
Help seeking	Use of the Forums or Chat
Time management	Using the Calendar
Strategic planning	Plugin Configuration - Monitoring oflearning plans
Self-monitoring	Plugin Configuration - Progress Bar (Completion Progress)
Organization (take notes)	Wiki Tracking
Self-evaluation	Carrying out self-assessment by means of a questionnaire

During the development stage, the Moodle server was also set up and the contents were migrated to the educational platform by the technical team in a structured manner according to the thematic and order proposed in the MOOC on Environmental Management and Sustainable Development. A domain name was created on the internet where the Moodle server and the

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corresponding MOOC on Environmental Management and Development are hosted at the web address: https://vivelaeducacion.com/cursos/.

Instruments

The instruments used for the evaluation were the OSLQ questionnaire (Barnard et al., 2009) and the Instructional Materials Motivation Survey (IMMS) (Keller, 2012). These two instruments are described below.

Online Self-Regulated Learning Questionnaire (OSLQ)

The OSLQ (Online Self-Regulated Learning Questionnaire) was created by Barnard et al. (2009). OSLQ was selected because it is the most widely used instrument to validate self-regulated learning in online environments with high reliability, as shown by Cerón et al. (2020) in their systematic literature review. Barnard et al. (2009) reported that the questionnaire has high internal consistency both at the level of the overall score ($\alpha = .90$) and at the level of the subscale scores, where Cronbach's alpha varies from .85 to .92. When applied in the present study, the reliability of internal consistency measured by Cronbach's alpha was .896 for the overall scores and varied from .682 to .860 for the subscale scores, as shown in Table 2.

Table 2

Reliability Coefficients for the OSLQ

Num.	Strategy	No Ítems	Cronbach's Alpha
1	Goal setting	5	0,709
2	Structuring the learning environment	4	0,823
3	Task strategies	4	0,682
4	Time management	3	0,784
5	Seeking help	4	0,860
6	Self-evaluation	4	0,793
	Total	24	0,896

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The Instructional Materials Motivation Survey

The Instructional Materials Motivation Survey (IMMS) created and validated in 2010 (Keller, 2010), understands motivation as a process of change in the person that gives them the strength to behave according to their feelings and reactions to achieve their learning goals.

The instrument measures four dimensions of motivation, which are Attention with a Cronbach's alpha reliability of 0.83, Relevance with a Cronbach's alpha of 0.81, Satisfaction with a Cronbach's alpha of 0.92, and finally Confidence with a Cronbach's alpha of 0.90. Each of these dimensions was evaluated throughout the 36 items that make up the questionnaire.

The instrument consists of 36 items, with items 1 to 12 measuring attention, items 13 to 21 measuring relevance, items 22 to 30 measuring confidence, and items 31 to 36 measuring satisfaction. The questionnaire responses correspond to a 5-point Likert scale, where 1 means not true, 2 somewhat true, 3 moderately true, 4 mostly true, and 5 very true.

The internal consistency estimates based on Cronbach's alpha, developed by Keller, were satisfactory. See Table 3.

Table 3

Reliability Estimates

Scale	Reliability Estimates (Cronbach α)
Attention	.89
Relevance	.81
Confidence	.90
Satisfaction	.92
Total Scale	.96

Results

Results of the effect of MOOC design on participants' self-regulated learning

Quantitative analysis of the data resulting from the application of the OSLQ questionnaire was performed using the statistical tool IBM SPSS version 26. Participants' responses to the

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questionnaire items were initially coded and the normality of the data was evaluated using the Kolmogorov-Smirnov test, which showed that the data were normally distributed.

A new variable called the level of self-regulation was calculated based on the rating scales of the questionnaire items. As shown in Table 4, the five scales were grouped into five levels of self-regulation: insufficient, low, basic, high, and superior.

Table 4

Levels of Self-Regulation

Response Range	Likert Scale	Self-Regulation Level
0 a 1,99	Totally Disagree	Insufficient
2 a 2,99	Disagree	Low
3 a 3,99	Neither agree nor disagree	Basic
4 a 4,59	Agree	High
4,6 a 5	Totally Agree	Superior

Table 5 shows the results of the descriptive statistical analysis of the OSLQ questionnaire results. The results revealed that the overall mean of the participants' responses is 3.97 with a standard deviation (SD) of .62, indicating a basic level of self-regulation overall.

Table 5

Descriptive statistical analysis of the OSLQ

Num.	Strategy	N	Mean	Self-Regulation Level	Standard Deviation
1	Goal Setting	154	4.0	High	0.7
2	Environmental Structuring	154	4.1	High	0.7
3	Task Strategies	154	3.7	Basic	0.7
4	Time Management	154	3,84	Basic	0.8
5	Seeking Help	154	4.1	High	0.8
6	Self-evaluation	154	4.0	High	0.7
	Total	154	3.97		0,62

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The results show that participants report a high level of self-regulation in goal setting, structuring the environment, seeking help, and self-assessment, and a basic level in task strategy and time management.

The relationship between the 6 subscales of learning self-regulation strategies was analyzed to verify if there is a significant relationship between two of the six subscales, calculating Pearson's correlation. The results are shown in Table 6.

Table 6

Pearson Correlation between SRL scales

		1	*2*	*3*	*4*	*5*	*6*
1	Goal setting	1					
2	Environmental Structuring	0,562	1				
3	Task Strategies	0,287	0,154	1			
4	Time Management	0,626	0,549	0,358	1		
5	Seeking Help	0,506	0,558	0,216	0,458	1	
6	Self-evaluation	0,505	0,567	0,334	0,528	0,727	1

The results show that there is a strong positive correlation between the six types of self-regulation strategies when tested in pairs, since the significance value in all pair results was $p < .001$ and r varied from 0.15 to 0.73. When examining the results, it was observed that the strongest relationship exists between the Self-evaluation strategy and the Seeking help strategy with a maximum correlation of 0.727, $p < .01$. This means that support for self-regulation is important to be offered in an integral way in the design of the MOOC.

Results on the Effect of the MOOC Design on Participants' Motivation

Table 7 shows the results obtained from the analysis of participants' responses to the IMMS instrument in the MOOC.

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Table 7

Motivation Factors

Motivation Factors		
Dimension	Average	Standard Deviation
Attention	4.1	0.6
Relevance	3.6	0.7
Confidence	3.7	0.9
Satisfaction	3,9	0.6

Regarding “Attention”, an average score of 4.1 and a standard deviation of 0.6 were obtained, as shown in Table 6. This indicates that participants in the MOOC maintain their attention. It is an indicator that the content is visually appealing and delivered in different formats, arousing sensory curiosity in the student. To increase this result, it is recommended to review the structure and design of educational resources to favor the generation of surprise and uncertainty more positively during the execution of the MOOC.

“Relevance” shows an average score of 3.6 and a standard deviation of 0.7, which suggests that students understand the importance of the objectives they pursue in the MOOC. Explicitly described objectives help develop relevance, as it is more likely that students will understand the expectations set. However, further improvements are needed to meet students' needs with the MOOC purpose and in this way increase motivation. On the other hand, is also important to create strategies to close the relation between the participants previous knowledge and the MOOC objectives, specifically indicating to participants this relation.

Regarding “Confidence”, the participants' responses show an average of 3.7 with a standard deviation of 0.9 according to Table 6. This indicates that the students' Confidence can be further strengthened. It is important to include in the design of the MOOC the use of precise rules and processes, clear learning examples, meaningful feedback, and the establishment of a safe learning environment in which there is a good degree of challenge. Gamification strategies could be used with this purpose as will be described in the next section.

The results also show an average Satisfaction of 3.9, with a standard deviation of 0.6, as can be seen in Table 6. The offering of a pleasant learning experience that increases the students' Satisfaction must be strengthened. Students should take more responsibility for their own learning.

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Despite the opinion that students do not engage in excessive responsibility, control must be maintained. Imagination, creativity, challenges, and difficult tasks could be used to increase satisfaction, boost self-esteem, and connect the current learning process with previous experience.

Results are promising and they have permitted to identify some opportunities of improvements that will be described in the next section.

Discussion

In this section we will discuss important findings that arise from the results shown in the previous section.

At first place is important to highlight the results of the OSLQ questionnaire shows a high level of implementation of self-regulation strategies by participants, which indicate the MOOC design following the Autorregúlate Methodology, achieves the goal of supporting students when learning by promoting the adoption of SRL strategies.

On the other hand, as indicated in the results of the OSLQ questionnaire, particularly in the Pearson correlation analyses conducted, self-evaluation and seeking help are two strategies that are strongly related and have a positive effect on participants self-regulation. This is evidenced by the fact that participants are constantly seeking help in forums, course chat, showing concern for improvement and continuously self-evaluating the process or activities presented. This complements the findings of Kizilcec et al. (2017), where goal setting, strategic planning, and time management have a positive effect on goal achievement.

Regarding the Keller motivation instrument, the category of Attention, which arouses curiosity and interest in students by stimulating perceptions such as surprise, uncertainty, novelty, participating in the inquiry of questions or problems, and creating a variety of exercises or models, was the best-rated motivation dimension with an average of 4.1. On the other hand, Relevance, related to students' experiences and needs and directed toward useful goals, was the lowest component with an average of 3.6. Similar results were obtained in this regard to the research carried out by Li y Moore (2018), where these two components occupy the same positions.

After reviewing the participants' level of study regarding self-regulated learning strategies, no significant change was found. The study showed that the students' educational level does not

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affect the use of self-regulation strategies, which is consistent with the findings of Barnard et al. (2009). This author examined the change in learning self-regulation strategies in a group of first-generation online students during a semester, and their findings did not reveal significant differences in students' self-regulation ability over time.

Different studies show that students who are able to self-regulate their learning tend to participate in more activities in MOOCs, and increase the possibility of completing the course (Littlejohn et al., 2016). For this research, it was demonstrated that goal setting and time management, strategies in which students showed greater proficiency, were relevant to improve self-regulated learning in a MOOC. Similar results to those of Kizilcec et al. (2017), a study where strategies such as goal setting, strategic planning, and time management had a positive effect on goal achievement.

The development of this scenario has allowed the generation of opportunities of improvements for the refinement of the Autorregulate methodology.

First, although students showed levels of 3.7 and 3.9 in the dimensions of confidence and satisfaction as components of motivation, it is considered important to define strategies to increase student confidence and satisfaction in the MOOC.

Gamification is a good strategy that has been validated and is described as an important factor for increasing student motivation in MOOC (Revelo et al., 2018) . Gamification could be designed following the Mechanics, Dynamics, and Aesthetics (MDA) design approach (Hunicke et al., 2004). The mechanics describe the components of the didactic strategy, that is, its rules and the actions or tasks that the students carry out in the gamified scenario (Helmefalk, 2019). The dynamics of gamification allow defining the objectives and fundamental rules, as well as the key factors for users to participate autonomously. On the other hand, The dynamics describe the operation of the mechanics to create the interactions between the students (Hunicke et al., 2004). The dynamics promote the interaction of the user in the Course, and usually are based on feedback systems. Finally, the Aesthetics concern the fun within the activity, that is, the desirable emotional responses of the player when interacting with the game (Hunicke et al., 2004), are concrete elements of power and mechanism such as avatars and badges (Hasan et al., 2019).

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Second, we conclude that a support tool for self-regulation, which helps MOOC participants in the planning, execution, and self-evaluation of learning, in addition to providing monitoring facilities for learning self-regulation strategies, can be a good alternative that will allow for the improvement of the adoption of self-regulation strategies by participants.

Finally, results allows us to highlight the design process of a MOOC that consider SLR is crucial for students to adopt self-regulation strategies as part of the learning process. The inclusion of particulars guidelines that come from the Zimmerman model, UDL, and the ADDIE model, not only allow designers to consider SRL strategies in the MOOC design but also invited students to adopt SRL strategies while learning. Autorregúlate Methodology offers to designer a well structured set of Phases which support students in their permanence and completion of the MOOCs.

Conclusions and future work

This article has introduced Autorregulate, a methodology for the design of massive open online courses that provides clear guidelines from the design to facilitate the co-creation of MOOCs that promote self-regulated learning by participants.

It has been shown that it is possible to support self-regulated learning strategies (planning, execution, and self-reflection of activities) from Moodle, using the tools provided by the platform, such as forums, chat, calendars, progress bars, wiki, and self-evaluations, with high participant interaction.

It was important to inform students about self-regulated learning and how to be a self-regulated learner in the context of the MOOC “Environmental Management and Sustainable Development” through a dedicated module on the topic, which had a positive impact on the results of the OSLQ instrument.

The analysis of the results of the application of the OSLQ instrument shows that the individuals who participated in the MOOC “Environmental Management and Sustainable Development” self-regulated during the course execution. These results are an indicator of the impact that the process of designing massive online courses guided by principles that favor student self-regulated learning can have.

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From the OSLQ questionnaire data, it could be seen that the students had a high degree of self-regulation, with a mean score of 3.98, with the most outstanding strategies being structuring the learning environment and help-seeking with a mean score of 4.1.

It is also worth mentioning in the analysis that the two strategies with the highest Pearson correlation were time management strategy and seeking help. This could indicate the need to offer more robust help mechanisms that impact the participants' time management.

As described, the principles of Universal Design for Learning were applied in the design of the MOOC and were evaluated using the Keller's motivational survey, showing high motivation in its components: Attention, Relevance, Confidence, and Satisfaction.

The positive results of the motivation evaluation show that the co-created MOOC design allowed students to establish clear goals, structure an organized learning environment, define strategies for task completion, manage time, seek help, and self-evaluate.

In this sense, gamification could be an alternative to increase student satisfaction, been also an interesting alternative for UDL implementation.

For future scenarios, it is recommended to support students not only by informing them about self-regulated learning but also by supporting their activity with ICT tools that favor specific SRL and self-control strategies.

Self-regulated learning plays a crucial role in students' learning habits, as if they can adopt planning, execution, and self-evaluation strategies that lead to the completion of activities, they can successfully complete the online course.

The findings of this research show that self-regulated learning is not a fixed trait and therefore can be favored through good practices implemented in the design of massive open online courses. The adoption of the good design practices introduced in this article can support the reduction of dropouts in this type of course. However, this should be the subject of future research.

Additional iterations of the methodology should be carried out in other MOOC from different areas, in other learning environments, to stablish comparison with the results of the run described in this study.

Compare the results of this work, based on the Zimmerman Model, with other similar works based on other models of learning self-regulation, could give insights regarding the impact of the model in the MOOC results.

On the other hand, it is a real opportunity to expand support for other learning self-regulation strategies based on the Zimmerman model in the context of MOOC.

Finally, it is of our interest to use more sophisticated algorithms to analyze the data obtained from the different iterations and evaluations of the methodology, in order to identify patterns and improve the results.

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